ISRO AGENCY REPORT ON OCEAN COLOUR ACTIVITIES IN INDIA

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Ahmedabad-380015,
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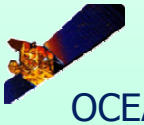
Evolution of EO based Services in India

KALPANA
INSAT-3D

IRS-1C/1D
RESOURCESAT-1
RESOURCESAT-2



OCEANSAT-2
SARAL/Altika

Satellite Meteorology

Crop Forecasting

Ocean State Forecasting

OCEANSAT-1
OCEANSAT-2

PFZ Mission

INCOIS

MNCFC, New Delhi
State Remote Sensing Centers

IMD

OCEANSAT-2
OCEAN COLOUR MONITOR (OCM-2)

Launched : 23 Sept 2009
Orbit : 720 Km
Inclination : 98.28 deg
Revisit cycle : 2-days
Swath/Resolution : 1420 Km/
360 m X 236m
Time of Pass : 12 noon
Along track Steering : ± 20 deg

Instruments on Oceansat-2

- OCM-2: Ocean Colour Monitor
- OSCAT: Ku-band Scatterometer
- ROSA: ASI's Radio Occultation Sounder for Atmosphere

(OCM-2 Optics side)

(detector head side)

OCM-2 Design

(8 VNIR spectral bands)

- 8-element telecentric lens assembly per band
- f-length: 20 mm ; f/no. = 4.3
- FOV: ± 43 deg
- 2-element bandpass filter + 1 thermal filter
- 3730 of 6k element linear array CCD device
- 12 – bit quantisation
- Exposure (gains) : 16 levels
- SNR > 512 at saturation (land reflectance)
- Band-to-band registration : ± 0.25 pixel
- MTF > 0.26
- 4 LED's as onboard cal source per band

Ocean Colour Activities in India

OCEAN COLOUR OPERATIONAL DATA PRODUCTS, CAL_VAL & DISSEMINATION

- Retrieval algorithms for Ocean colour parameters over case-1 waters, coastal and inland waters
- Inversion algorithms for quantifying absorption and backscattering process (IOP estimation)
- *In-situ* database on AOP, IOP and in-water constituent concentrations for seas around India

OCEAN & COASTAL BIOGEOCHEMISTRY

- Carbon components (POC, DOC & Phytoplankton Carbon) & Carbon fluxes (Primary, New & Export production) from satellite
- Photo-synthetically Available Radiation (PAR)
- Nitrate Estimation using Ocean Colour and SST

Marine Living Resources Management

- Marine GIS based Ecosystem Management
- Fish Stock assessment using Primary production

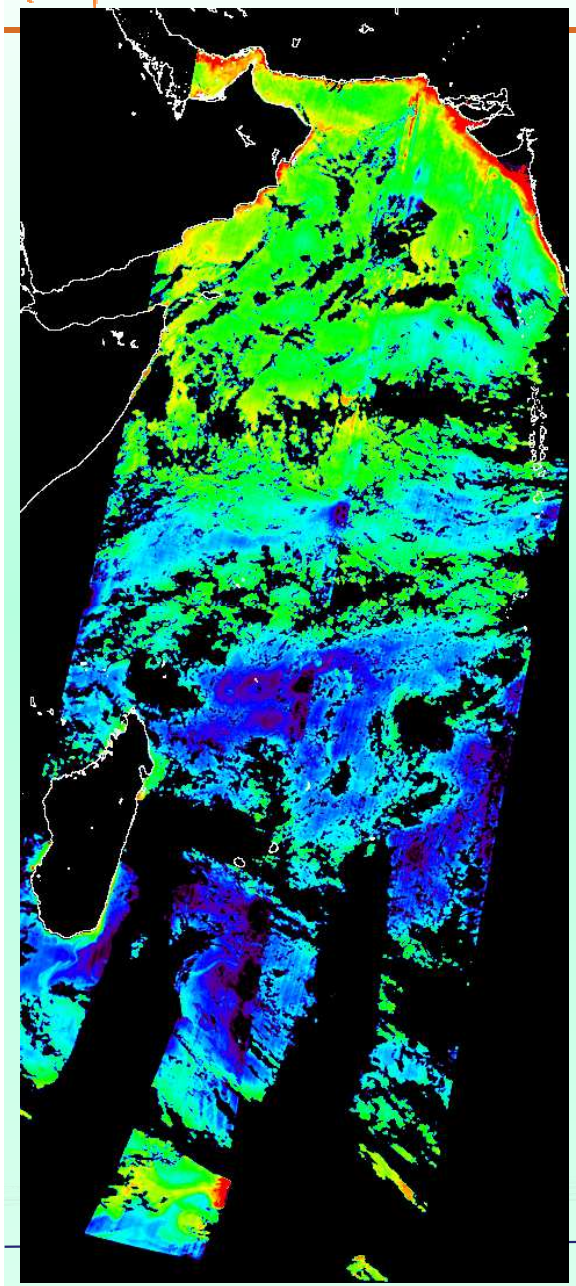
CLIMATE CHANGE STUDIES

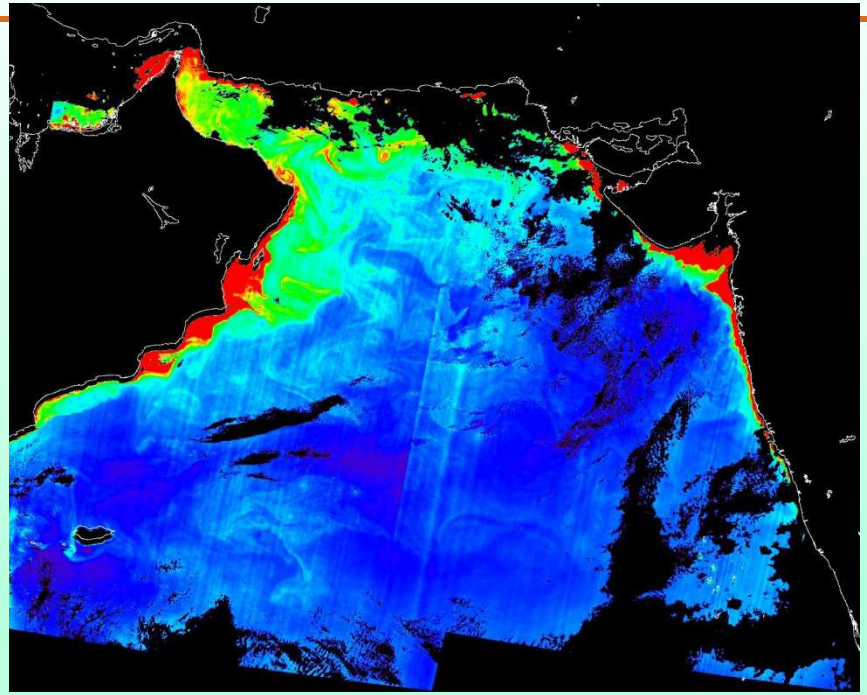
- Decadal scale spatio-temporal phytoplankton variability in the Indian Ocean region
- Cyclone induced productivity

APPLICATIONS FROM INDIAN GEOSATIONERY (INSAT-3D) SATELLITE

- Mapping Aerosols & dust storms
- High temporal resolution SST maps of Indian Ocean

Update on OCEANSAT-2 OCM



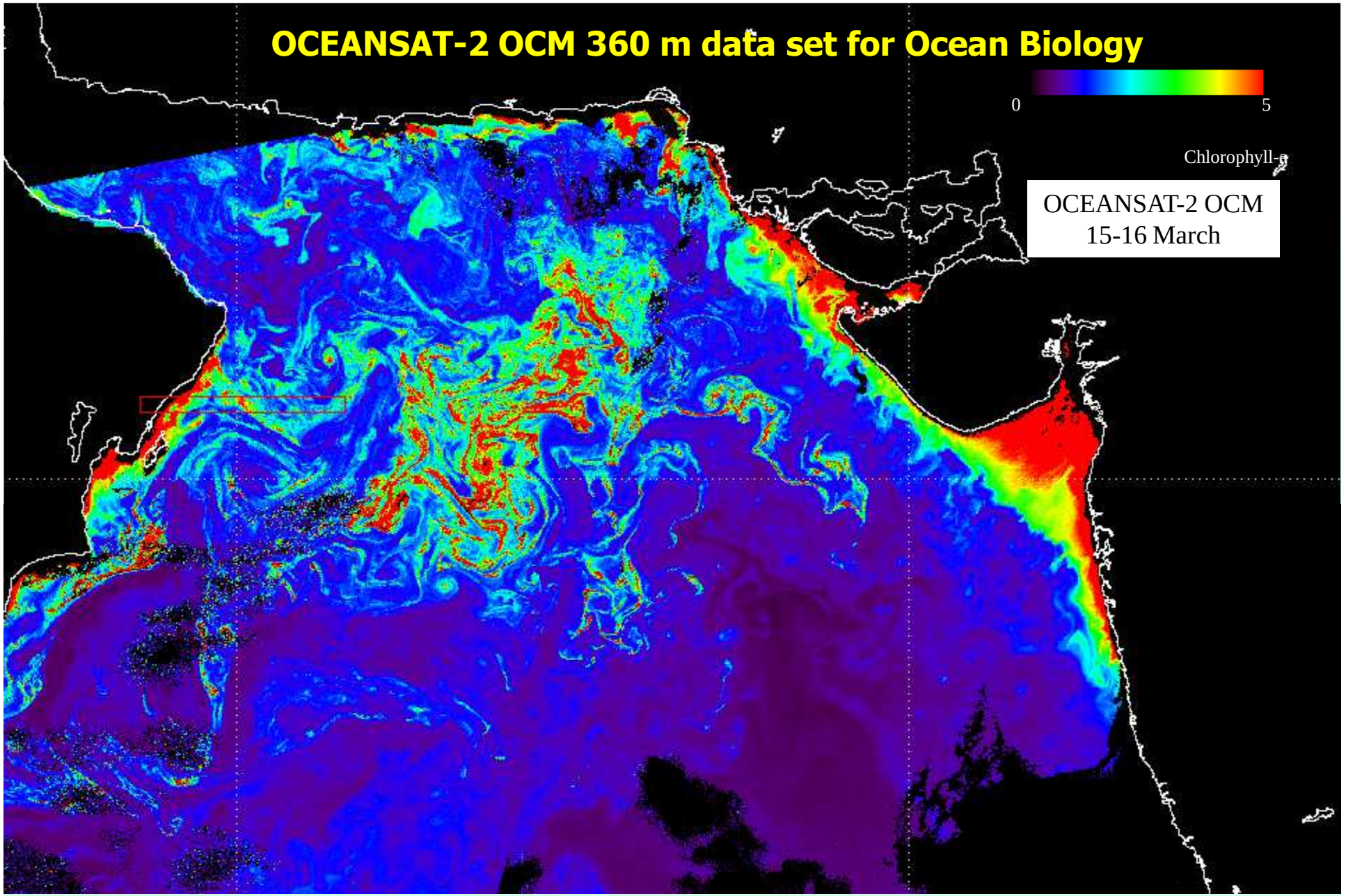


April 15-16, 2014 OCM-2 Chlorophyll

- Removal of yaw Rotation on March 13, 2014
- Scene to Scene mosaic have improved
- Reduction in banding on edges
- OCM payload is working nominally
- Five years of ocean colour data around India & Globe

OCM-2 Chlorophyll
Dec 26-27, 2014

OCEANSAT-2 OCM 360 m data set for Ocean Biology



- Massive Phytoplankton Bloom in the Arabian Sea is dominates the ecosystem and causes hypoxia
- Multi year analysis of satellite data show enhancement in bloom area, this is likely to affect fisheries

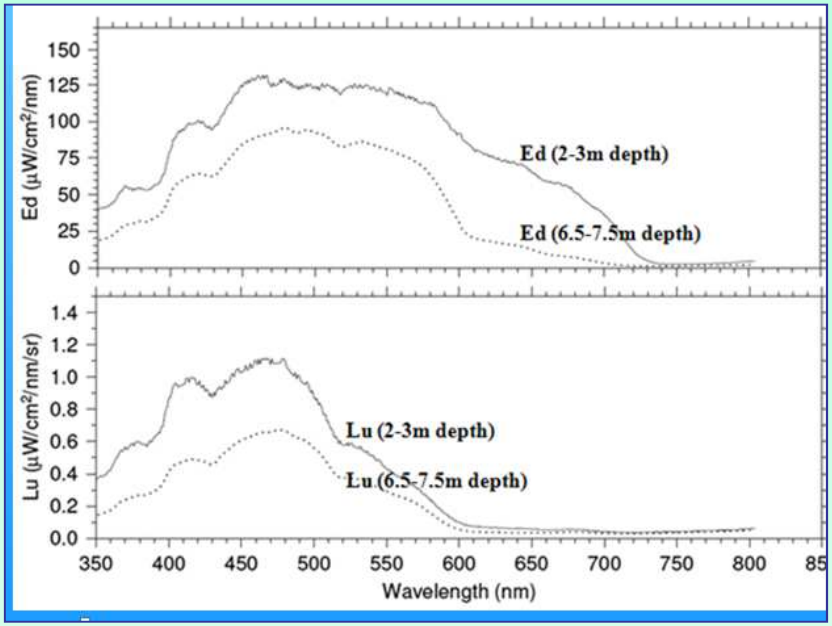
Vicarious Calibration of OCM -2

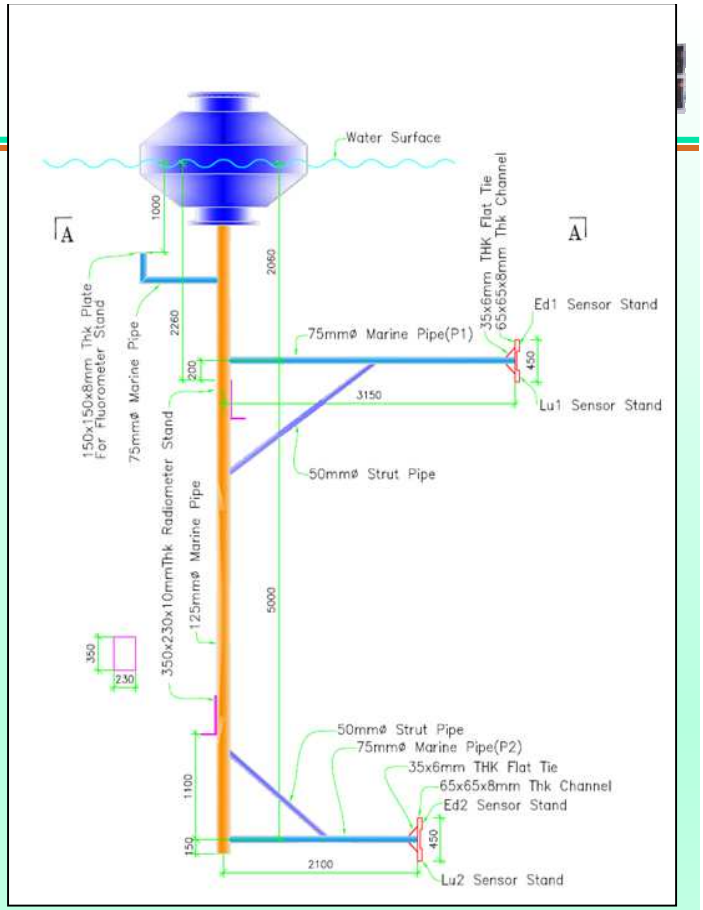
Vicarious calibration is considered as a tool for

- verifying the pre-launch calibration data
- evaluating possible sensor decay with ageing

Cal/Val site at Kavaratii in Arabian sea

- *In water sea reflectance* data is being collected in low chlorophyll waters (<0.125 mg/m^3);
- Under clear atmospheric conditions (AOD_{870nm} < 0.2); using hyper spectral instruments; and well calibrated field instruments

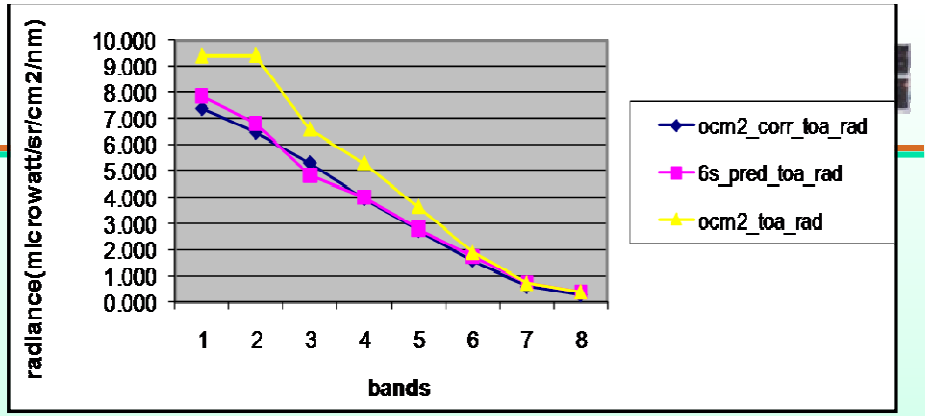


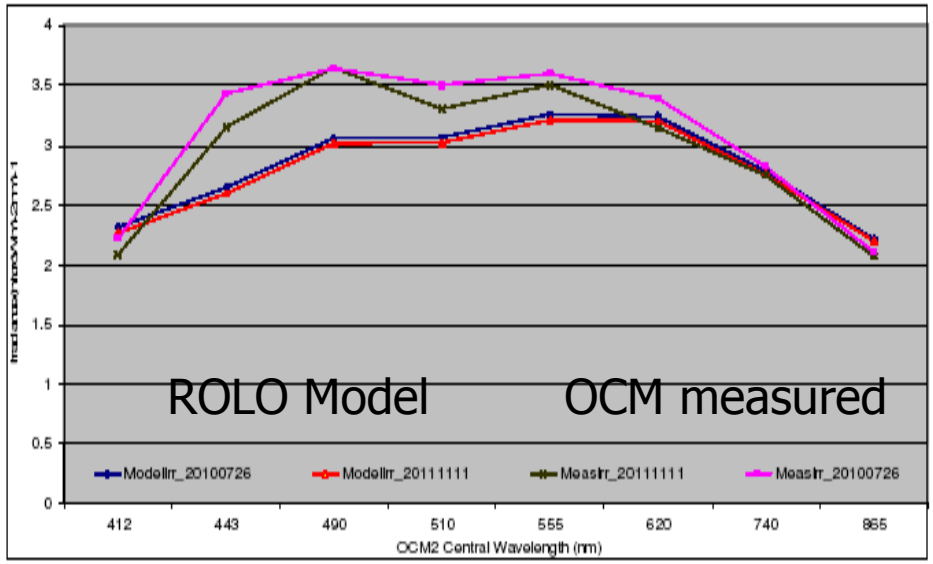


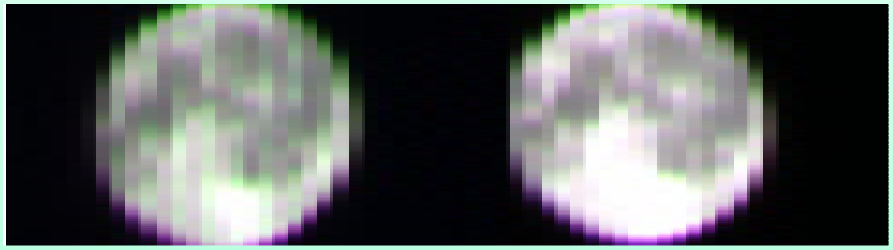
Absolute Radiometric Cal & Lunar Calibration of OCM -2

Three Moon acquisitions for OCM-2 were done

26-7-2010, 11-11-2011 and 1 Aug 2012

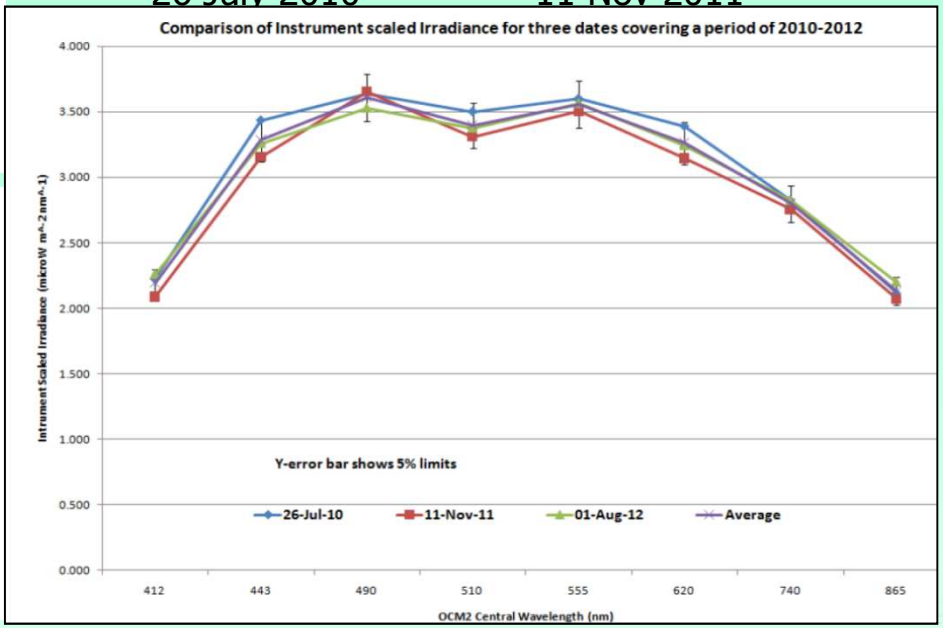




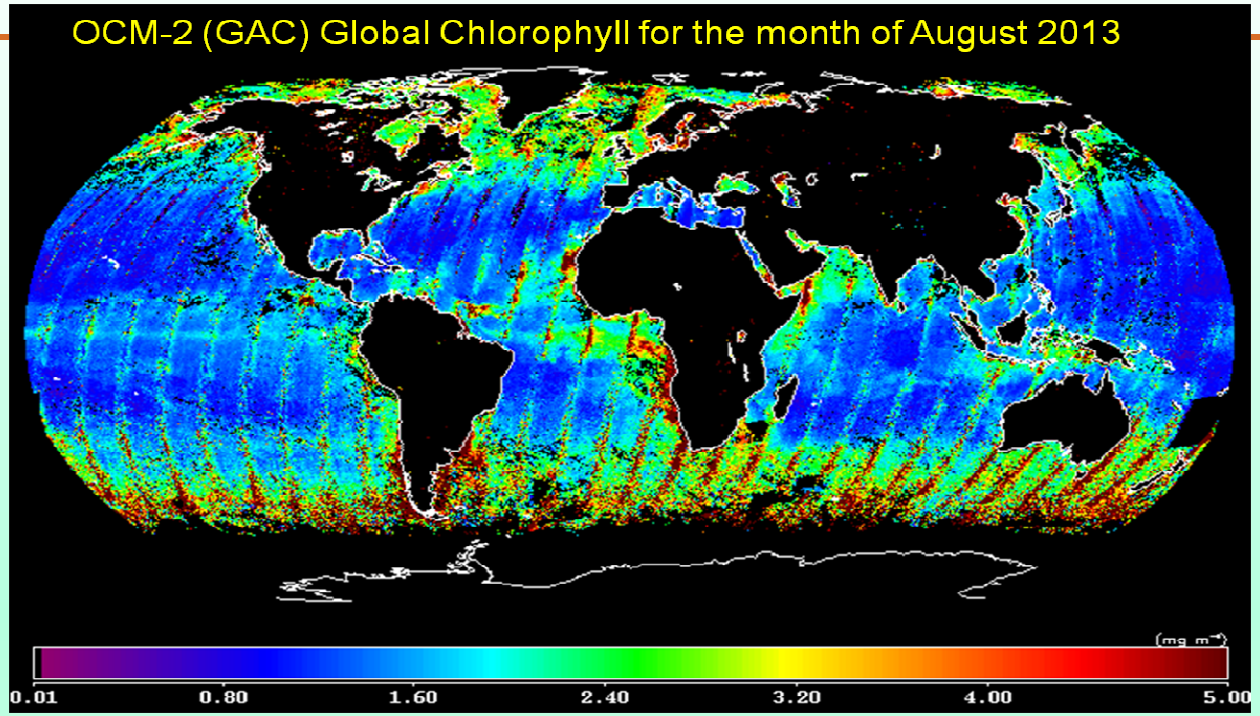


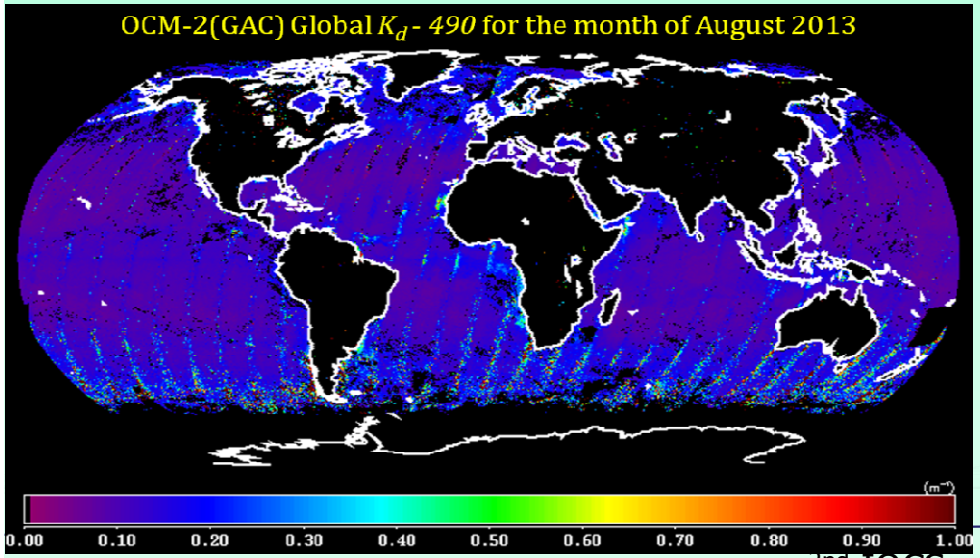
26 July 2010 11 Nov 2011

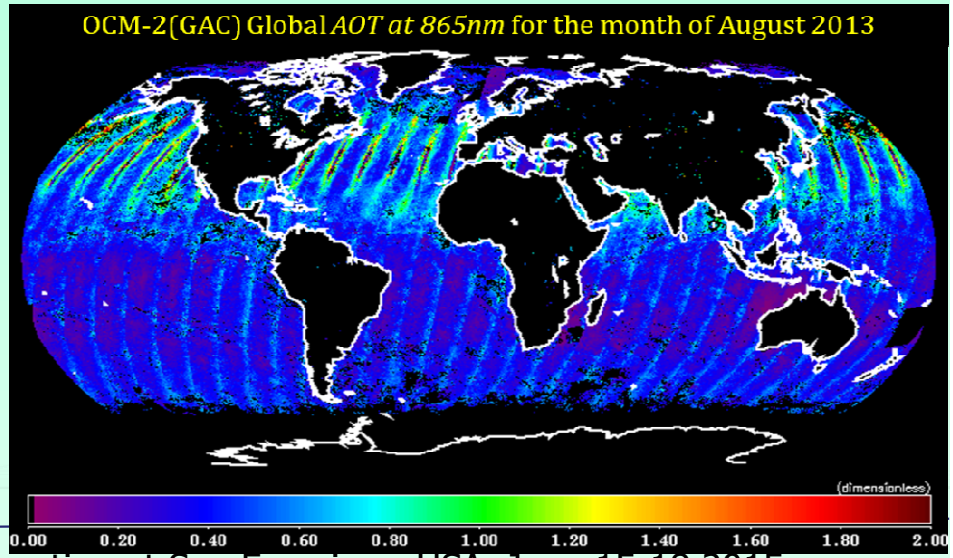
CW (nm)	260710	111111	% variation of 111111 wrt 260710
412	1.041152	1.087995	4.499151
443	0.770421	0.824635	7.036932
490	0.841481	0.825392	-1.91199
510	0.876796	0.914517	4.302141
555	0.904445	0.917074	1.396326
620	0.955636	1.018487	6.576877
740	0.986744	1.003452	1.693246
865	1.050061	1.063507	1.280497



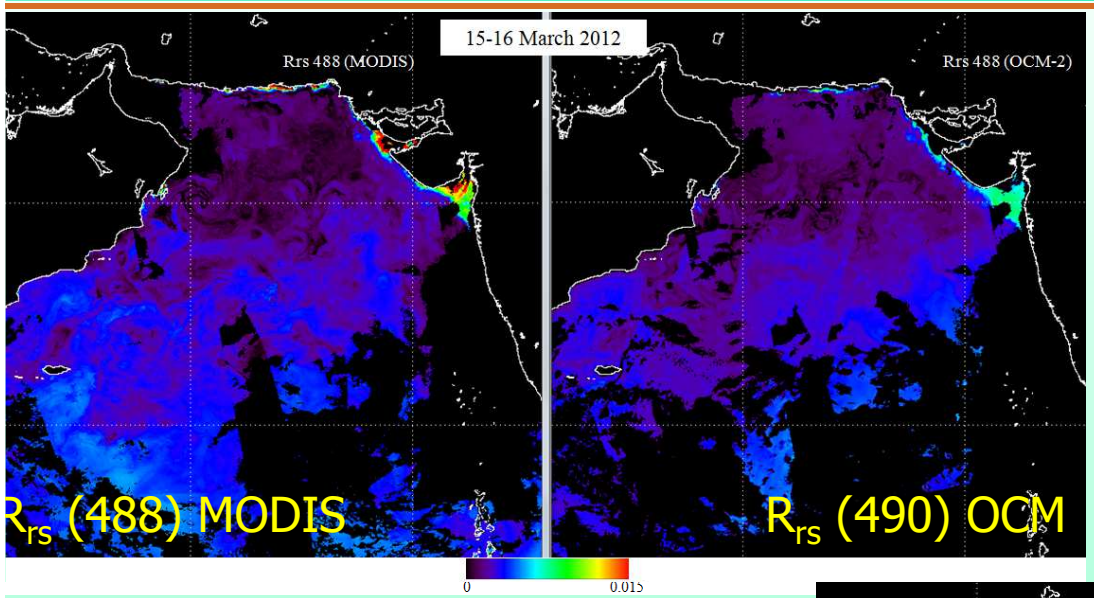
Global Monthly products from OCM-2

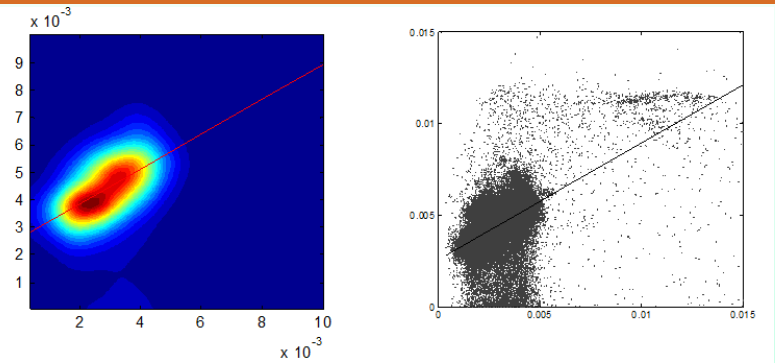




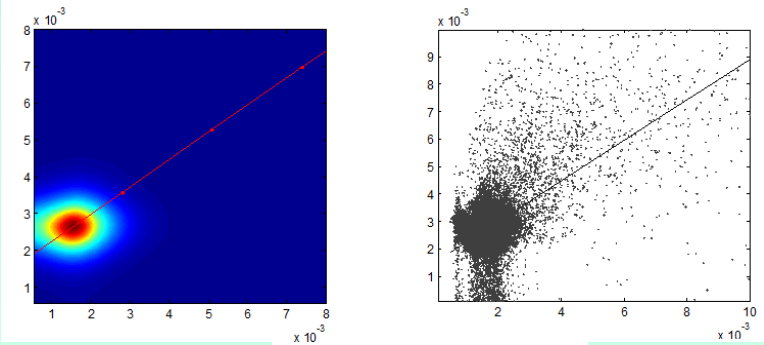


Inter Sensor companion of OCM & MODIS data

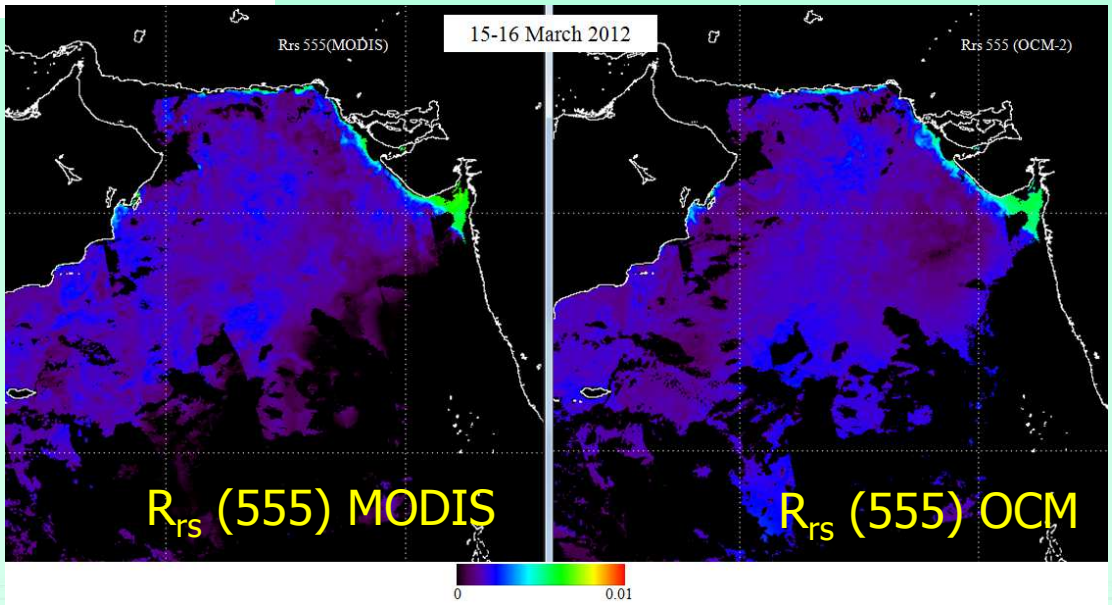




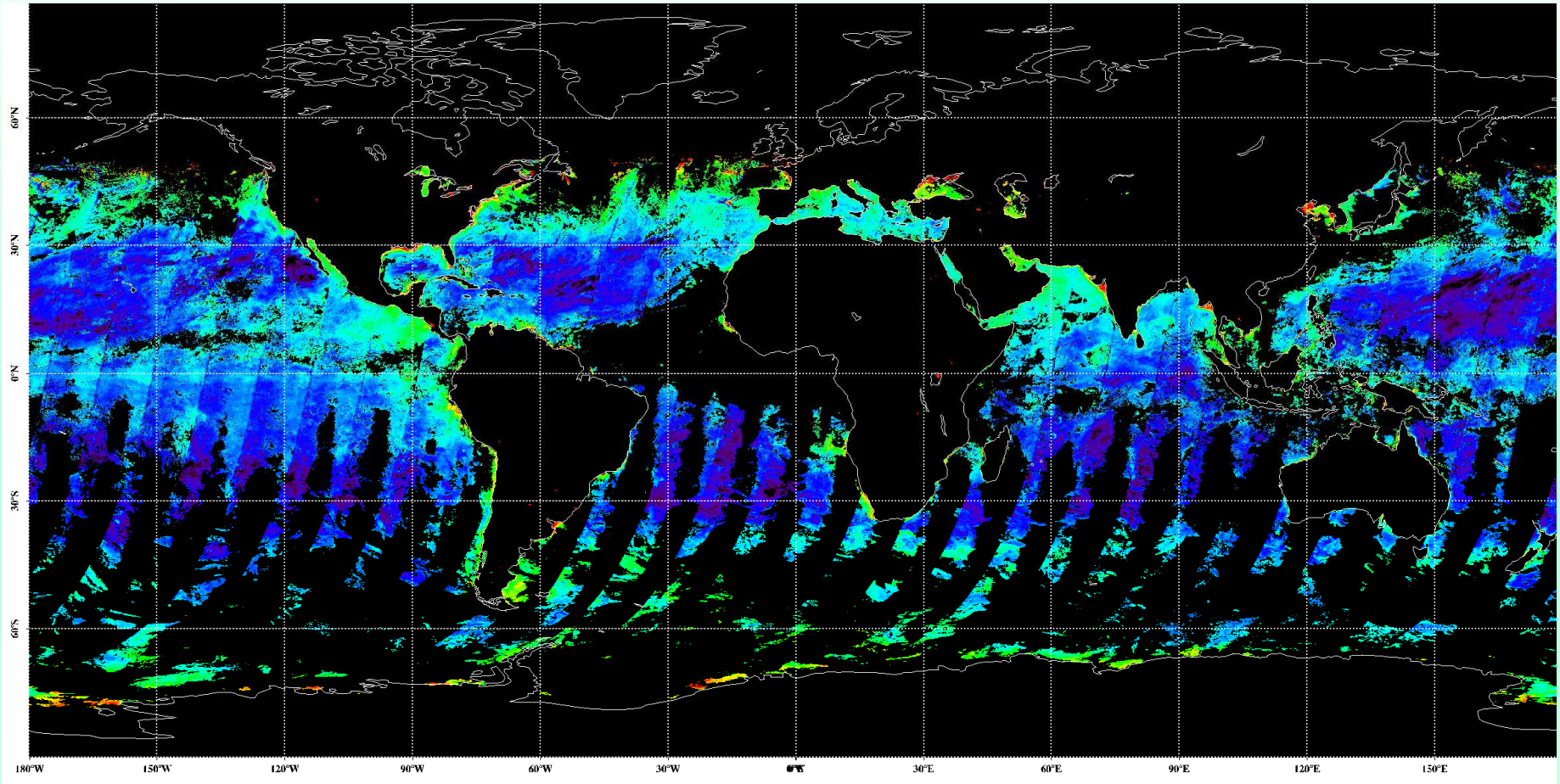
Y=Rrs(490) OCM
X=Rrs(490) MODIS
Y=0.65X+0.002573
R=0.65
RMSE=0.001



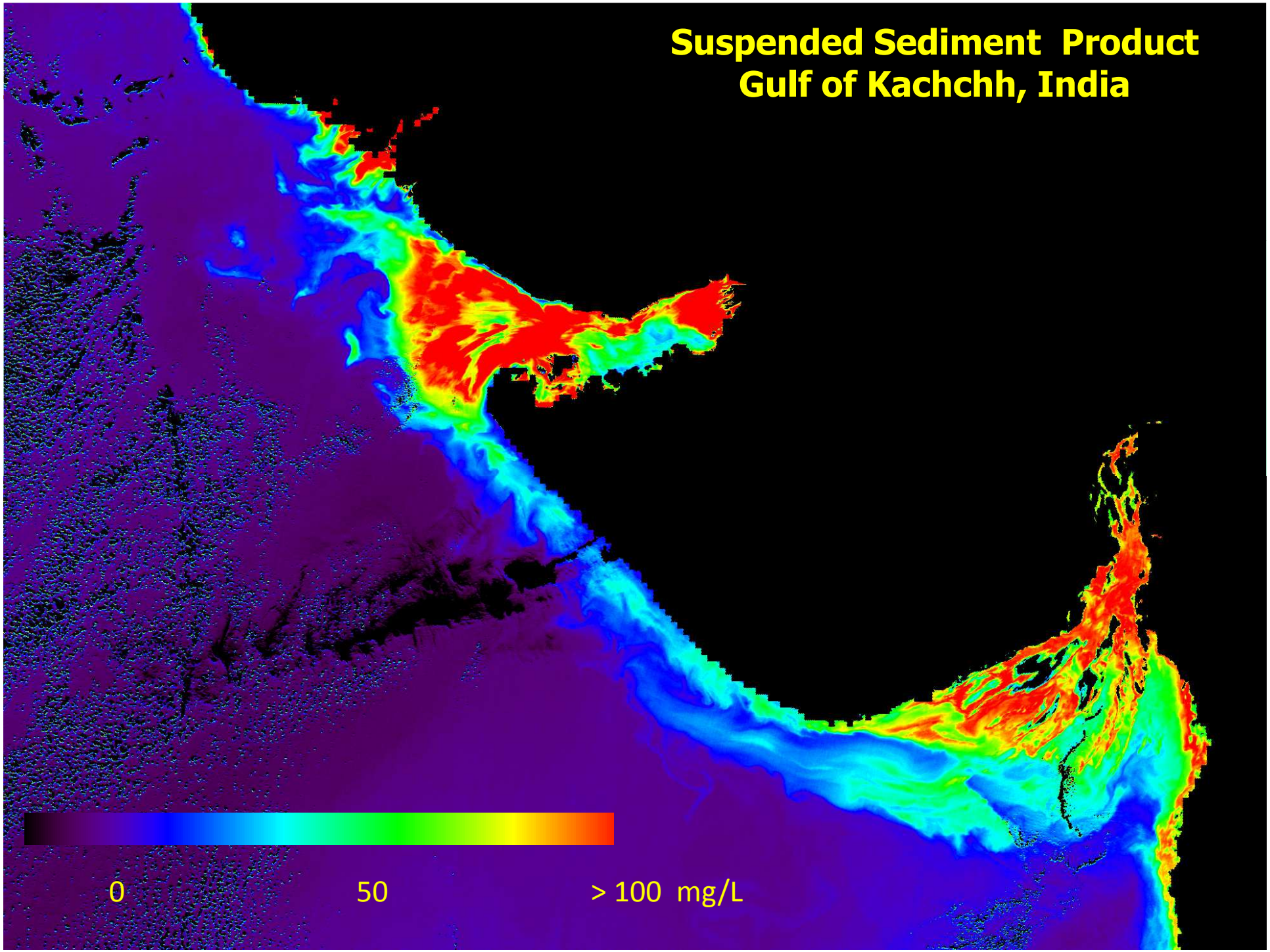
Y=Rrs(555) OCM
X=Rrs(555) MODIS
Y=0.74X+0.0015
R=0.85
RMSE=0.0007



Reprocessed Global Chlorophyll-a distribution (January, 2012)

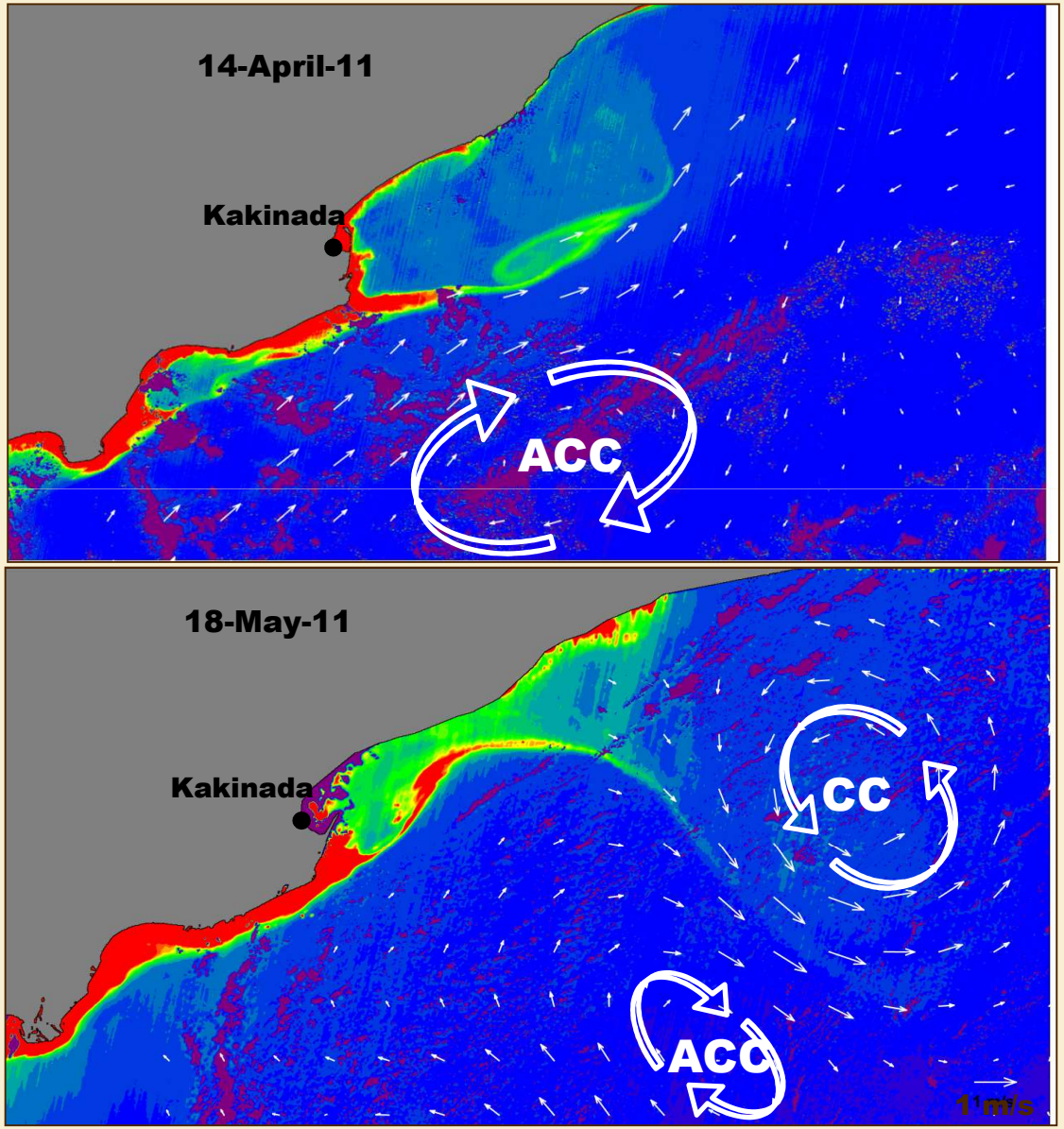


Chlorophyll-a mg/m^3

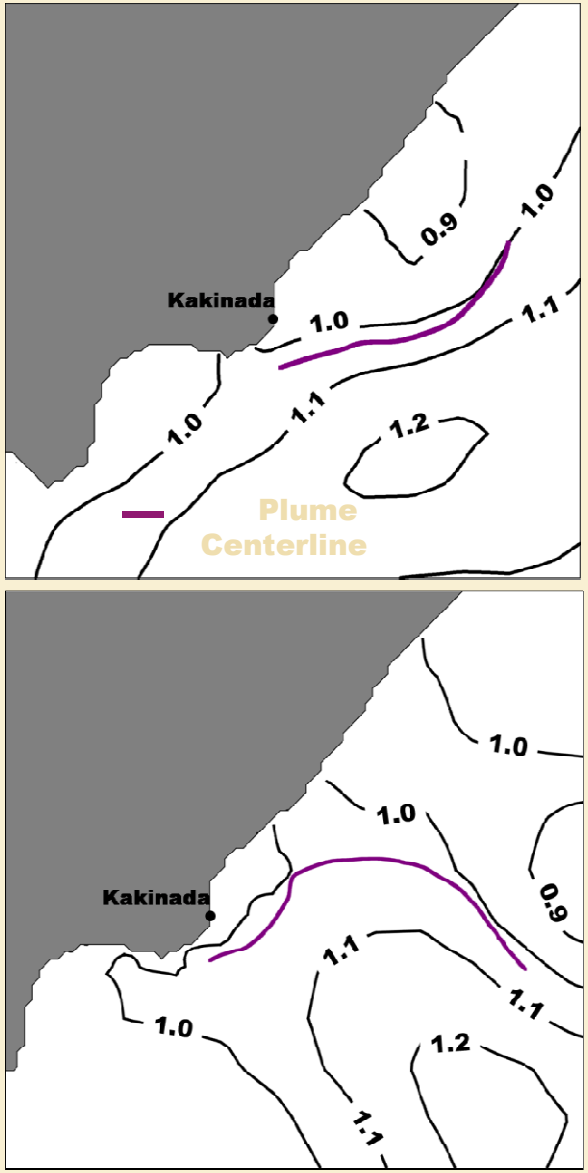

Suspended Sediment Product
Gulf of Kachchh, India
0
50
> 100 mg/L

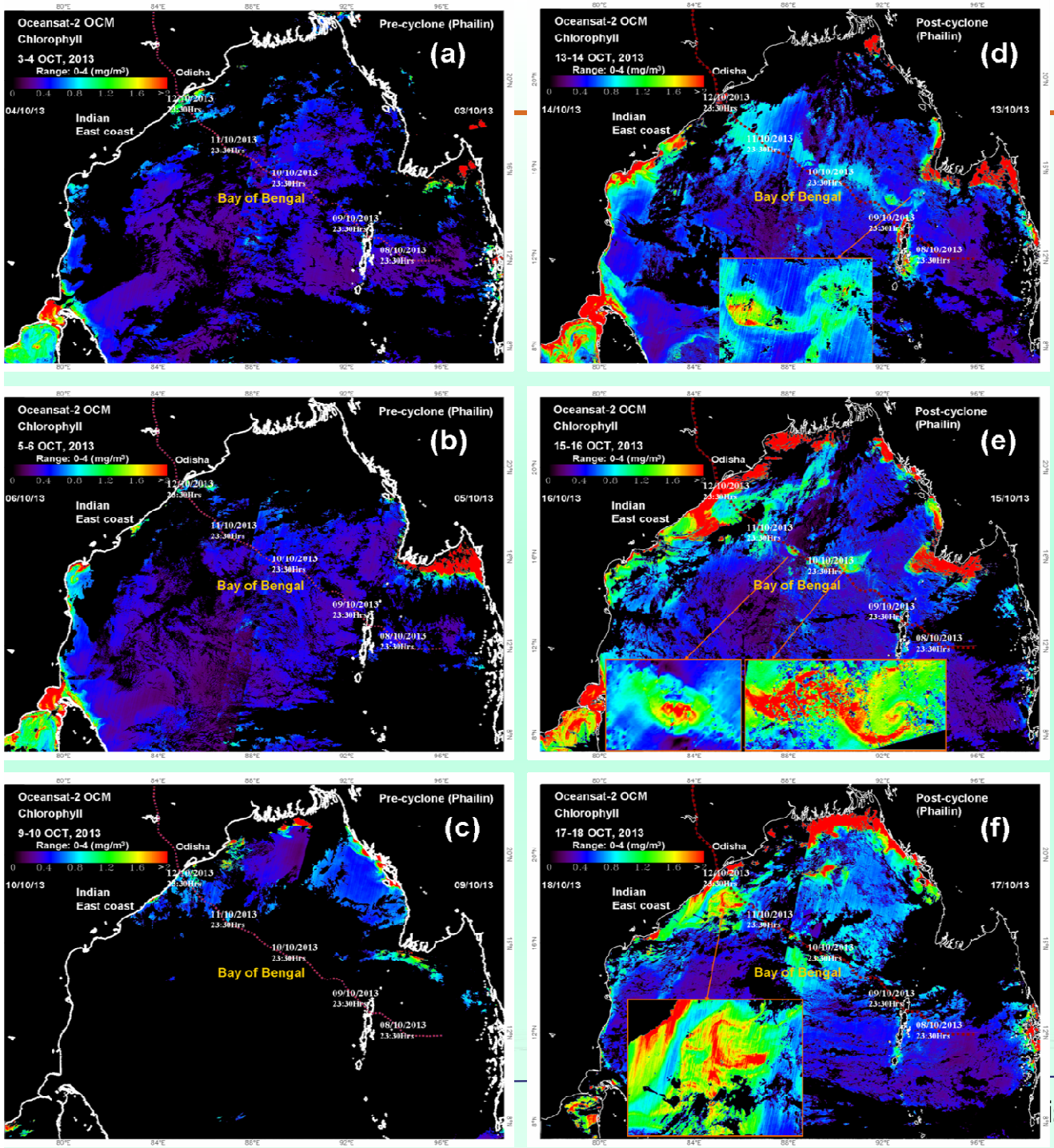
Coastal eddies and plume dynamics

OCM-2 SSC overlaid with OSCAR current



Sea surface height (Altimeter)

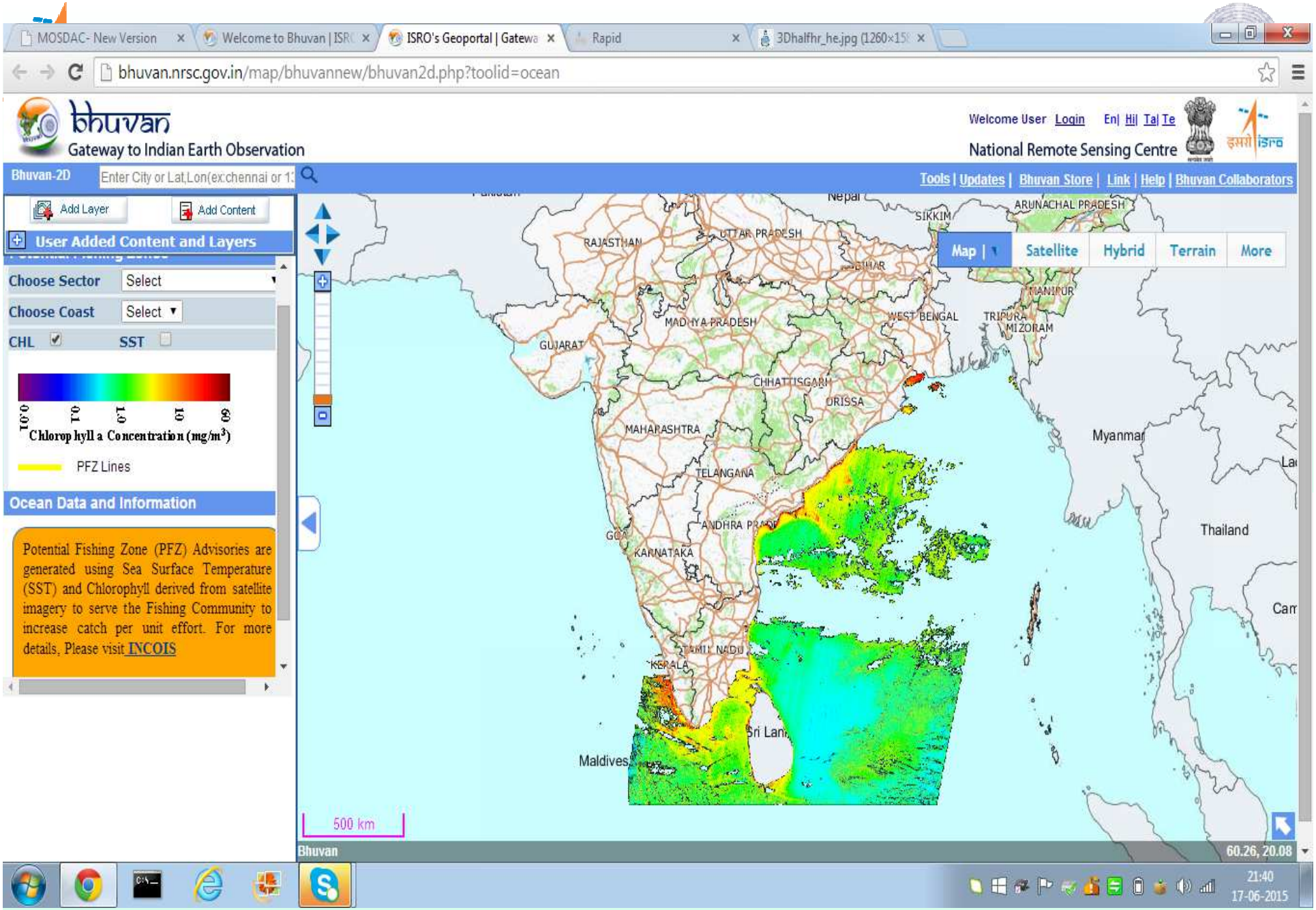




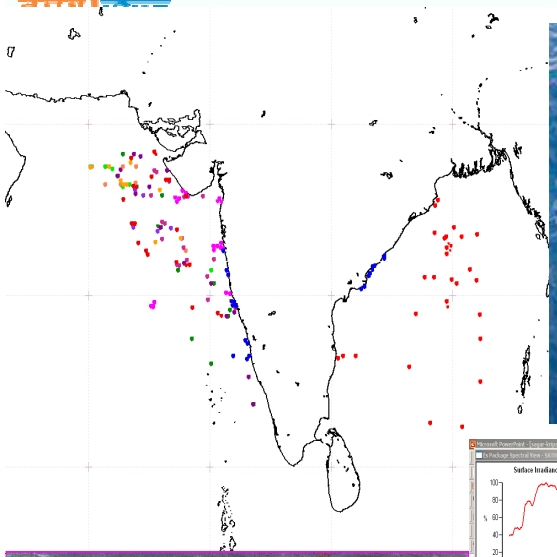
Cyclone Induced Ocean Productivity

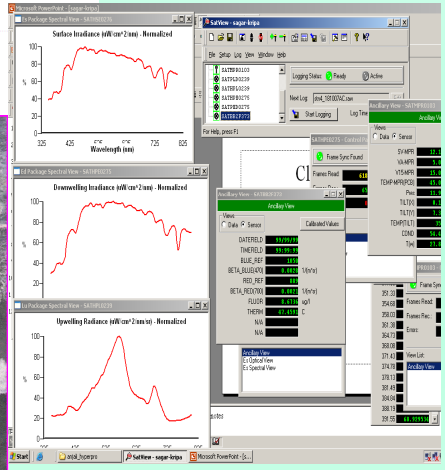
Cyclone Phailin

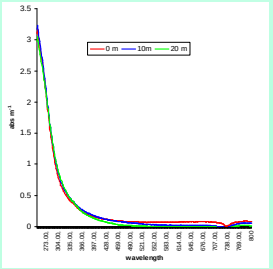
Capture by OCEANSAT-2 OCM

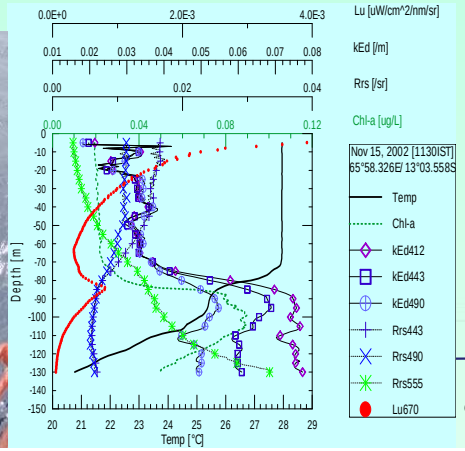

MOSDAC- New Version
Welcome to Bhuvan | ISR
ISRO's Geoportal | Gatewa
Rapid
3Dhalfhr_he.jpg (1260×15
bhuvan.nrsc.gov.in/map/bhuvannew/bhuvan2d.php?toolid=ocean
bhuvan
Gateway to Indian Earth Observation
Welcome User Login
En| Hi| Ta| Te
National Remote Sensing Centre
Bhuvan-2D
Enter City or Lat,Lon(ex:chennai or 1
Tools | Updates | Bhuvan Store | Link | Help | Bhuvan Collaborators
Add Layer
Add Content
User Added Content and Layers
Choose Sector
Select
Choose Coast
Select
CHL
SST
0.01
0.1
1.0
10
60
Chlorophyll a Concentration (mg/m3)
PFZ Lines
Ocean Data and Information
Potential Fishing Zone (PFZ) Advisories are generated using Sea Surface Temperature (SST) and Chlorophyll derived from satellite imagery to serve the Fishing Community to increase catch per unit effort. For more details, Please visit INCOIS
Map
Satellite
Hybrid
Terrain
More
Nepal
SIKKIM
ARUNACHAL PRADESH
RAJASTHAN
UTTAR PRADESH
BIHAR
MANIPUR
MADHYA PRADESH
WEST BENGAL
TRIPURA
MIZORAM
GUJARAT
CHHATTISGARH
ORISSA
MAHARASHTRA
Myanmar
TELANGANA
ANDHRA PRADESH
GOA
KARNATAKA
Thailand
TAMIL NADU
KERALA
Sri Lanka
Maldives
500 km
Bhuvan
60.26, 20.08
21:40
17-06-2015

In-situ Bio-Optical data collection





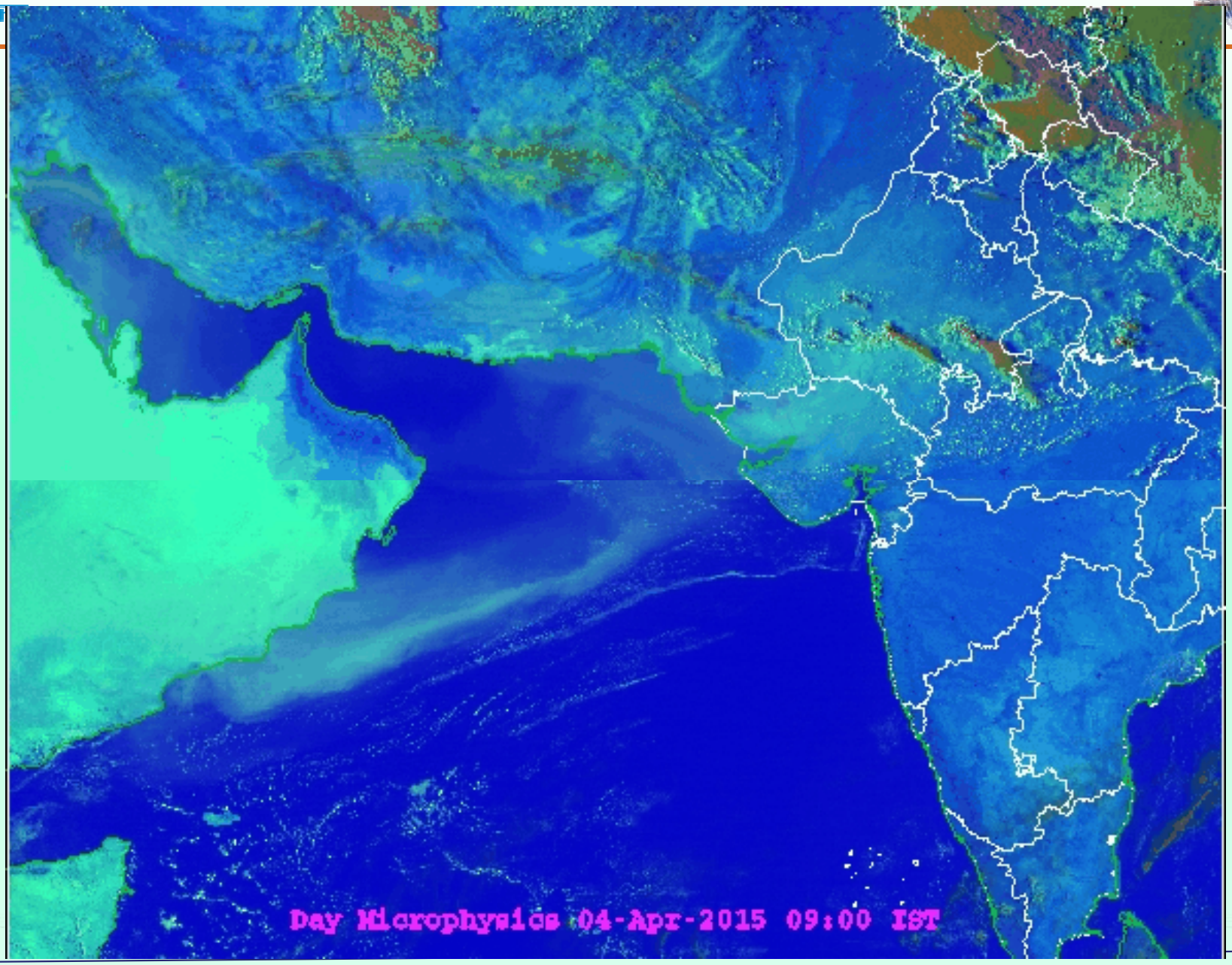




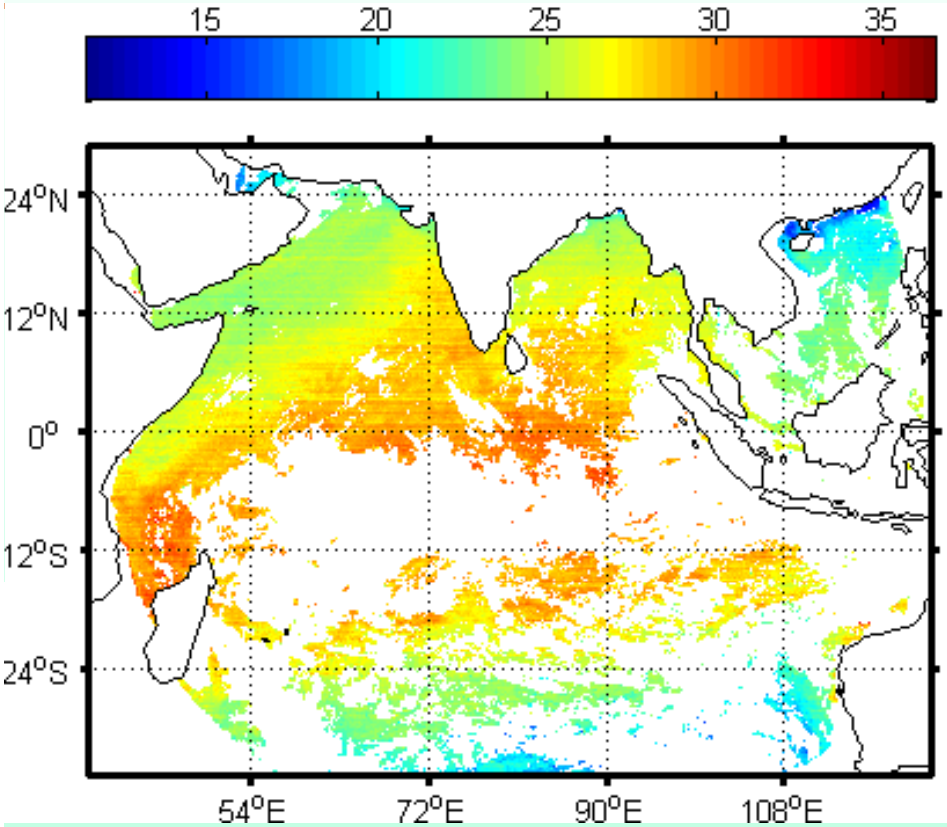
- In-situ data collection in collaboration with other National Institutes and Universities.
- Measurement & Analysis according to Ocean Optics Protocols

- Radiometric measurements
- Spectrophotometeric measurements
- HPLC
- Fluorometry
- CTD
- Microscopy
- Nutrients
- pH
- DO
- Ancilliary data
- Aerosol optical depth
- C^{13} and N^{15} Measurements
- POC & DOC

Dust Strom Monitoring using INSAT-3D Imager on April 04, 2015

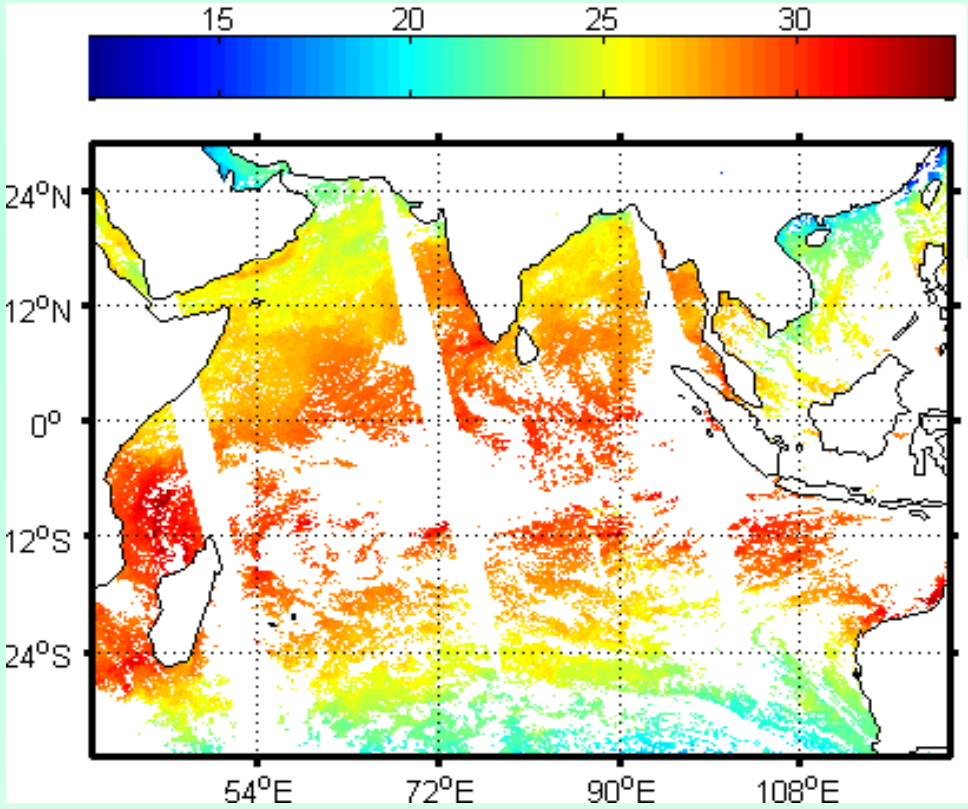


SST Maps from Indian Geostationary Satellite (INSAT-3D)



INSAT-3D SST (January 31, 2014 Daily Composite)

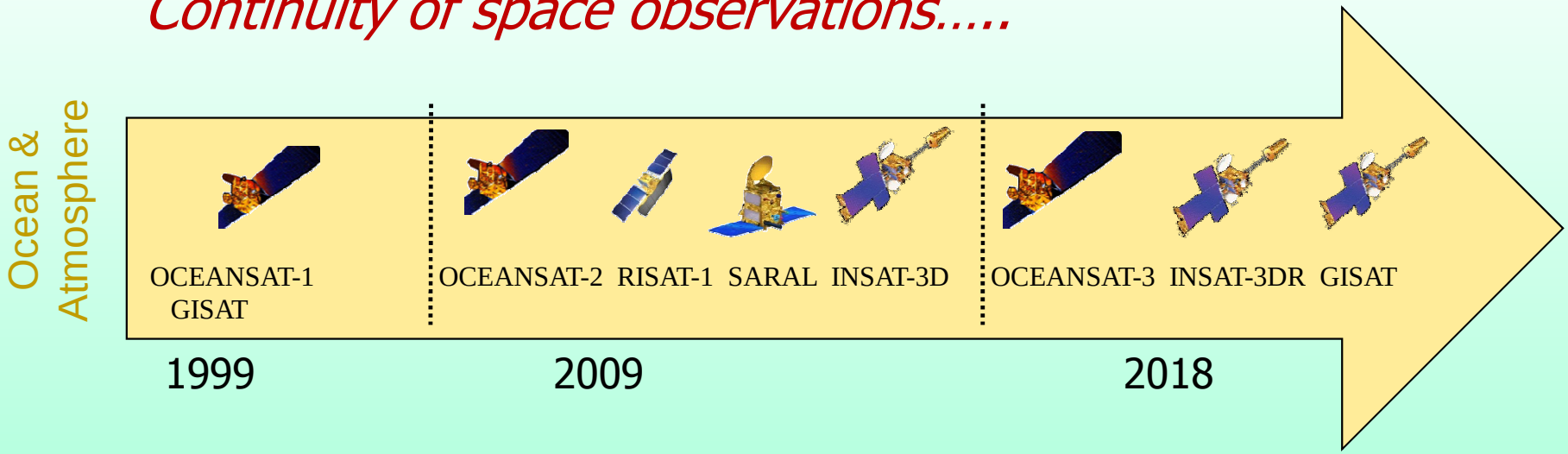
- High temporal resolution data
- Split Window thermal bands (10.3-11.3, 11.5-12.5)
- Spatial Resolution 4 Km



MODIS (Aqua) SST (January 31, 2014 (Daily composite)

Future EO Satellites for Ocean Observation

Continuity of space observations…..



OCEANSAT-3

Global Ocean Coverage

Payloads

- **13 Band Ocean Colour Monitor**
- **2 Bands for SST**
- **Ku Band Scatterometer**

Status

- **PSLV Launch 2017-18**

GISAT

Multiple acquisition from Geosynchronous Orbit

Payloads

- High resolution MX (50 m) - VNIR (HRMX-VNIR):
- Hyper spectral VNIR & SWIR: 320m and 192m Res.
- TIR 1.5km (HRMX-TIR)

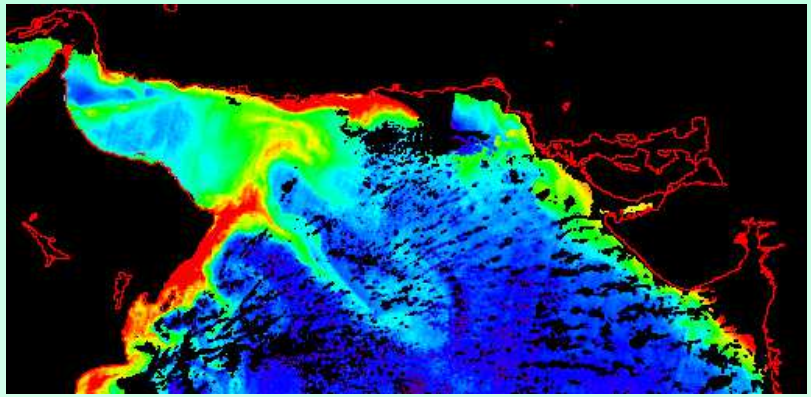
Status

- PSLV Launch 2016/17

Oceansat-3 OCM Instrument

- Oceansat OCM 3 for assured continuity
- 13 Channels in 400-1010 nm range in comparison
- 2 Channels around 11 and 12 µm for Sea Surface Temperature
- Bandwidth 10 nm or lower.
- Polar Sun Synchronous Global Mission
- Local Area Coverage at 360m and Global Area coverage at 1 Km
- Complete Globe coverage in 2 days

Baseline Design Review (BDR) for OCEANSAT-3 data Launch 2018



Old bands New bands

Ocean Colour Bands

Band No.	λ_c (nm)	Application Potential
B1	412	Yellow Substance Absorption
B2	443	Low Chlorophyll-*a* concentration
B3	490	Moderate Chlorophyll –*a* concentration
B4	510	High Chlorophyll –*a* concentration
B5	555	Chlorophyll-*a* reference band
B6	566	Trichodesmium bloom (Phycoerythrin pigment) detection for nitrogen cycle
B7	620	Algal bloom detection and Sediment concentration
B8	670	First Baseline for Chlorophyll Fluorescence
B9	681	Chlorophyll Fluorescence detection
B10	710	Second baseline for Chlorophyll fluorescence
B11	780	Atmospheric correction; avoids O_2 absorption band
B12	870	Atm. Correction. Good separation from previous bands. Better for coastal waters
B13	1010	Atm. Correction. over for coastal waters

SST bands

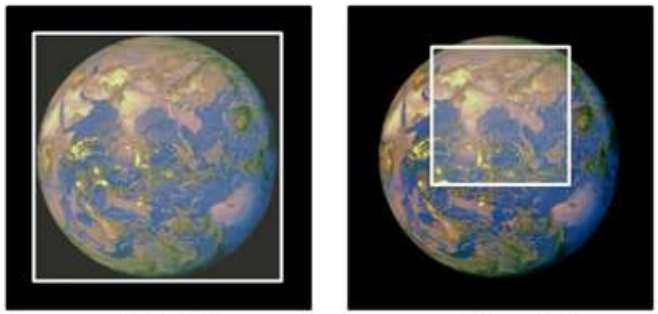
B14	11250	Sea surface temperature detection
B15	12250	Sea Surface Temperature detection

GISAT: Sensor System

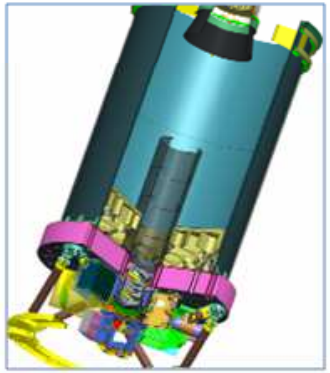
GISAT Payload Features

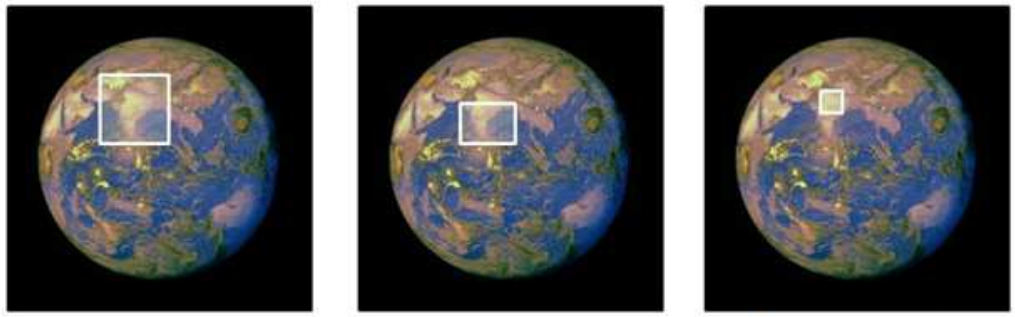
Sensors	Spectral Bands	Spectral Region (um)	Spatial Res. (m)	Swath (km)	Remarks
MX- VNIR	6	0.45 – 0.86	<50	470	MX-Optical
HySI- VNIR	154	0.38 – 1.0	320	160	Hyperspectral (5 nm)
HySI- SWIR	256	0.90 – 2.5	200	190	Hyperspectral (10 nm)
MX-LWIR	6	8.20 –12.5	1500	470	Thermal

Scan modes of GISAT

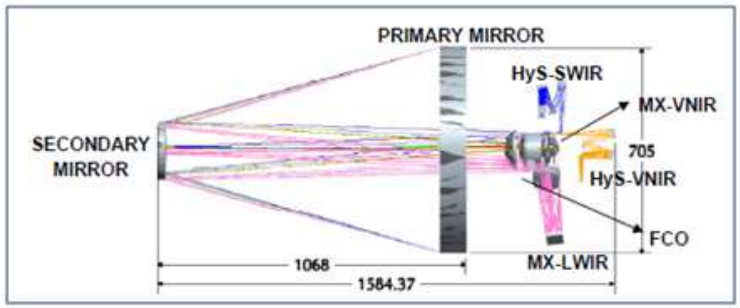


18°*18° 10°*10°





5°*5° 3000km*3000km 1000km*1000km



OCEAN & Atmosphere EO Missions – Near Future

NASA-ISRO SYNTHETIC APERTURE RADAR (NISAR)

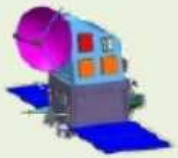
Orbit 747km
6AM/ 6PM

Design & Development of Dual frequency (L & S Band) Radar Imaging Satellite jointly by ISRO & NASA

Applications

- Estimating agricultural biomass over full duration of crop cycle
- Improving the forest biomass estimates
- Monitoring disasters like flood, oil slick, forest fire, etc.
- Regional level applications - Ground water monitoring, coastal zone studies, landslide, land subsidence studies, Mangrove characterization, etc
- Science applications like Monitoring the dynamics of ice sheets/ mountain glaciers, Assessing soil moisture in the agricultural fields, etc.

SCATSAT-1



Wind Vector Data for cyclone Forecasting and numerical modeling

Payload

Ku-Band Pencil Scatterometer

Orbit : 720 km
Local time: 18:00 hrs

ISRO-JPL collaboration
AVIRIS – Airborne flights in India

- *Coastal Ocean Colour Theme*

Thank You